

Measures for Energy-Efficient Northern Housing

Overview

AN OVERVIEW AND HISTORY
OF THE
MEASURES FOR
ENERGY-EFFICIENT NORTHERN HOUSING

Prepared by Larsson Consulting for
Energy, Mines and Resources Canada

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1: Introduction and Background

The Measures for Energy-Efficient Northern Housing (or Northern Measures) contains draft energy-oriented building requirements intended to be suitable for residential construction in the North, including the Northwest Territories, the Yukon and those portions of provinces which experience permafrost. The Northern Measures has been prepared by an intergovernmental and interdepartmental committee under the general direction of Energy, Mines and Resources Canada.

The broad terms of reference for the task of preparing the Northern Measures were established by the federal government, through the Treasury Board. The Treasury Board instructions stated that a standard was to be produced in time for the 1984 building season, and that the federal government would thereafter require all residential buildings falling within its jurisdiction to be constructed according to the standard.

Energy, Mines and Resources Canada (EMR) was assigned the lead role in the task, and consequently established the Northern Residential Standards Committee in 1982. EMR solicited the active participation of the Territorial and provincial governments on the committee, as well as those federal departments with a major interest in the North. Considerable emphasis was also placed on obtaining the involvement of private-sector designers, builders and organizations. The result was a three-level structure, including an Advisory Committee, a Technical Committee and a small working Technical Subcommittee. The head of the Secretariat for the project was an EMR official located in Yellowknife, who was provided with support by a consultant technical advisor in Ottawa.

The goal of the project was to produce a residential construction standard which would result in significant energy savings in new housing built in the North. An early decision was made to broaden this mandate to cover a broad range of construction problems unique to the North on the basis that it is not sensible to increase energy efficiency if other factors that can lead to the rapid deterioration of the building fabric are not addressed.

As the project evolved, it became apparent that it would be premature to designate these proposed requirements as a standard. This led to the use of the term "measures" and a decision to distribute the document for comment by design professionals, builders and other potential users during a 2-year review period ending in December, 1986. The current document is therefore not intended to be used directly, but rather to serve as a discussion document to generate comment, which in turn may lead authorities having jurisdiction to adopt it as a standard after it has been finalized.

Energy Mines and Resources Canada intends to elicit comments from key public and private-sector organizations and individuals during the review period and to prepare a discussion paper in early 1987 summarizing reactions to the Northern Measures and suggesting possible implementation plans.

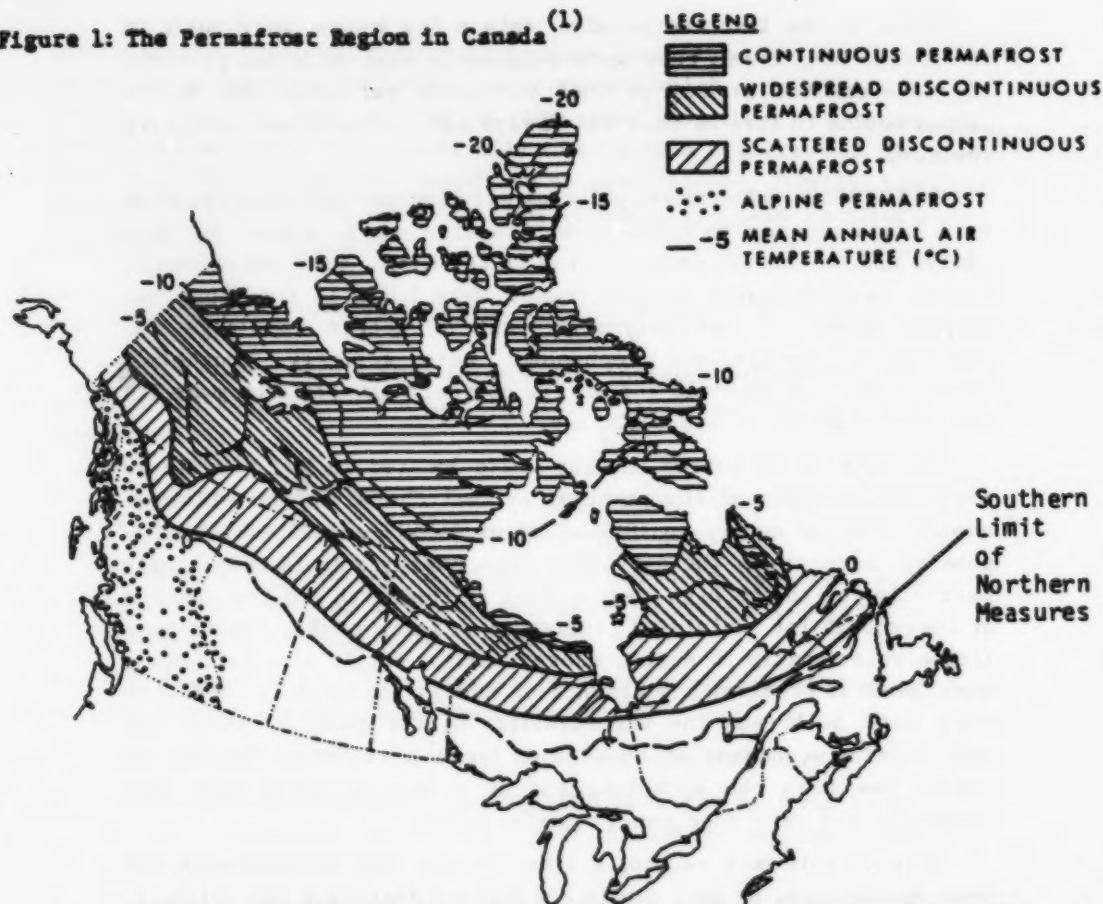
A two-stage process will be used in which reviewers are asked to forward to EMR their initial comments by January 31, 1986 based on their review and/or use of the Northern Measures to design homes for the 1986 construction season. In addition, reviewers are being asked to provide final comments by Dec. 31, 1986 based on their experiences with the construction of homes designed to the Northern Measures during the 1986 construction season.

2. A Working Definition of the North

The terms "North" and "northern housing" are frequently used in the Northern Measures. Although some would argue that all Canadian locations are northern, the long periods of extreme cold and the permafrost soils of this region are clearly different from conditions in most parts of the ten provinces. The Northern Measures is therefore designed to apply to the area north of the southern limit of the zone of scattered discontinuous permafrost.

As Figure 1 indicates, the zone in question takes in all parts of the two Territories and a significant portion of the provinces, but it must be emphasized that the line is not an exact one. It will also be seen that the boundary line bears some relationship to the isotherms of mean annual air temperature, but that the relationship is by no means a perfect one.

Figure 1: The Permafrost Region in Canada (1)



3. The Need for the Northern Measures

The severe climatic conditions of the North are largely responsible for the high level of per-capita energy consumption in that region. The absence of locally available forms of energy and the high cost of transporting fuels to many areas, especially to the Northwest Territories, aggravate the problem, with the result that the average cost of fuel for space heating and generation of electricity in NWT is the highest in Canada. The problem, however, is not only one of climate, but extends to the type and quality of housing which has been built in the North over a period of many years.

(1) Source: Johnston, G.H., Ed., Permafrost Engineering, John Wiley & Sons, Rexdale, Ontario, 1981

Prior to the last two decades, only a few houses were built in the North. In general, they were reasonably well built and provided adequate shelter as long as fuel was cheap and available. Native people tended to live as they had always had, in tents and temporary shelters.

In the 1950s, government policies were introduced which resulted in a crash program to build more "Canadian"-style houses for both native and non-native people living in the North. Hundreds of small, simple, prefabricated plywood houses were built in the south and shipped north for assembly. For want of better knowledge and experience, design and technology were strictly "southern", workmanship was poor and the severe northern climate soon made its effects apparent on the buildings.

The 4000 or so public housing units located in NWT provide an excellent example of the problem, in that there was an estimated annual average outlay in 1981 of about \$4150 per unit for energy subsidy costs alone. The extremely high energy cost is undoubtedly partially due to the high cost of fuel in the North and the absence of incentives for individual tenants to conserve energy (rents bear little relationship to actual energy costs), but it also reflects a more general problem: the absence of energy standards at the time they were built and the unsuitability of the general design and construction standards which were in force at the time. The overall result has been the establishment of a housing stock with poor longevity and very poor energy performance.

Despite this poor record, a considerable body of knowledge has been accumulated by both public and private designers and builders. It is therefore now possible to specify designs and construction techniques which will result in durable and energy-efficient housing. This is in fact being done by a number of public agencies, such as the NWT Housing Corporation and the Quebec Housing Corporation, and by some private builders, but the problem which remains is to ensure that this knowledge is transmitted to all those who design and build in the North, so that the general quality of construction can be improved in the very near future.

Recognition of this situation led the federal government to decide to produce the Northern Measures as a first step. In addition to the Northern Measures, a variety of other approaches may have to be adopted to provide a satisfactory degree of improvement in the situation, including the development of standards and manuals of

good practice, training, demonstrations and incentives. The Northern Measures is therefore only one of many methods which can address the problem, but it may be one of the most important in those jurisdictions where it is eventually adopted as a requirement. The most important issues that remain to be resolved are, firstly, the process of adopting the Measures, and secondly, the need to ensure its on-going maintenance.

4. Principles Followed in Preparing the Northern Measures

The following points summarize the principles followed by the working sub-committee in preparing draft clauses for the Northern Measures:

1. The chief objective is to reduce the amount of energy used in the operation of small residential buildings.
2. A secondary objective is to use the Northern Measures as a vehicle for setting an acceptable lower limit for the general standard of building construction.
3. The requirements of energy efficiency cannot be allowed to compromise the safety of the occupants.
4. Cost-effectiveness must be an important consideration.
5. Interpretation and use of the Northern Measures must not be too heavily dependent on access to engineers or sophisticated analytical techniques.
6. Equipment and systems that are required must be certified, trouble-free and readily available.
7. Attempts must be made to achieve a balance between the flexibility made possible by performance standards and the clarity resulting from the use of prescriptive standards.

5. Structure of the Northern Measures

It was decided to base the Northern Measures as closely as possible on the "Residential Standards, Canada 1980", a CMHC document with which most Canadian designers and builders are very familiar. Another major element in the new Measures is the inclusion of almost all of the changes which are included in the 1985 National Building Code. In summary, the Northern Measures contains much that is new, especially in Sections 5, 15, 16, 19, 26, 32, 33, 34 and 40, while many other sections contain at least a few changes.

6. A Simplified Overview of Northern Measures Requirements

The preparation of a standard (or, in this case, a Measure) is not a cut-and-dried affair. A requirement can be performance-oriented ("... the bedroom shall provide for sleeping and clothes storage for two adults ...") or it can be prescriptive ("... the bedroom shall have a minimum area of 9.8 m^2 and a minimum dimension of 2 m, and the closet shall...."). Usually, requirements are a mixture of both, since performance criteria leave the designer with options in reaching a solution, whereas prescriptive statements have the virtue of clarity and ease of enforceability.

The energy-related provisions of the Northern Measures are primarily prescriptive, with some provision for performance criteria. The Northern Measures provides a compartmentalized approach, with no trade-offs being permitted between the thermal performance of walls and the performance of furnaces or the provision of heat recovery equipment. Trade-offs are permitted between glazing and the opaque envelope, as long as the average performance of the above-grade envelope remains at the same level. The rationale for this approach is that, whereas the envelope and glazing tend to be permanent features of the building, the continued presence or efficiency of heating or heat recovery equipment cannot be guaranteed.

Thermal Insulation

One of the most important features of the Northern Measures is the use of a table of minimum RSI values for the above-grade building envelope. The table is based on an economic optimization formula, and allows the designer the choice of using the table alone or using the full formula upon which the simplified table is based. The full formula leads the user to select the most cost-effective level of average thermal performance of the envelope, given the following data:

1. Degree-day regime of the area
2. Incremental cost of adding insulation
3. Cost of fuel

The simplified table is based on the same factors, but makes the assumption that the cost of fuel will always be 10% of the

incremental cost of improving the thermal resistance of a wall area of 1.0 m^2 by RSI 1.0. The values in the simplified formula will be referred to by most users of the Northern Measures, but if the Northern Measures were to be adopted, the authority having jurisdiction would always retain the option of implementing the full formula.

A unique aspect of this approach is that it provides an RSI value which is the same for all assemblies above grade, whereas conventional systems provide for greater RSI levels in roofs and exposed floors. The Northern Measures requirement is based on the premise that the trend towards using similar structural sections for walls, floors and cathedral roofs in northern construction makes it sensible to specify the same RSI values for each situation.

Foundation walls below grade have been treated as a separate problem, since heat losses in this case do not vary with degree-day regimes in a consistent manner.

Despite the single minimum RSI value produced by use of the R-optimum (R_{opt}) approach, designers are, of course, free to improve the performance of various parts of the envelope, such as the roof. This may be to the designer's advantage, since another provision allows trade-offs to be made in envelope performance between various envelope sections, including glazed areas. In this regard, it should be noted that the minimum glazed area (for light) has been reduced from the 1980 CMHC Residential Standards (RS 1980), and a maximum glazed area has been established, along with an incentive to provide south-facing glazing.

The final basic element in the Northern Measures approach is an absolute minimum RSI value of 5.0, a figure which must be reached by all above-grade assemblies despite the operation of the trade-off provision.

Airtightness and Ventilation

One of the largest energy requirements in a relatively well-insulated building is that of heating air introduced for ventilation or as a result of infiltration/exfiltration processes. The Northern Measures has approached this problem by requiring a high degree of airtightness accompanied by a requirement for a controlled rate of mechanical ventilation.

If mechanical ventilation is used, the system must be able to provide up to 1.0 air changes per hour (ach) during normal operation, a requirement which is in accord with National Building Code provisions.

Heat recovery devices constitute an important potential method of reducing the net amount of heat energy lost due to air exchange. The Technical Committee came to the conclusion that this type of equipment is not yet developed to the point where it should be required in the Northern Measures. A few clauses have been introduced to deal with the voluntary use of this type of equipment, the most important being that heat recovery systems must not unbalance the ventilation system or reduce ventilation performance in the event of breakdown.

Combustion Equipment

Differentiation is made between combustion appliances that require the use of a flue and those that do not (gas stoves, refrigerators). Many of the requirements for isolation of equipment apply only to appliances with flues.

Combustion appliances are required to be isolated from living spaces, either by the design of the appliances themselves, or by placing them in a combustion equipment room, so that combustion products cannot be drawn into the living spaces. This has been achieved by placing restrictions on interaction between the appliance and the living spaces in both Section 33 and Section 34.

Fireplaces and solid-fuel stoves are permitted if they conform to the isolation requirements and are provided with direct external air for combustion.

Glazing

Glazing requirements are a blend of 1985 NBC and 1983 NRC Energy Measures requirements, with some strengthening of both. The NBC requirements for minimum glazed areas have been reduced; and while the NRC Energy Measures approach to a maximum area of glazing has been followed, the areas are reduced. As in the NRC Measures, south-facing glazing is given preference, a trade-off with the performance of the solid envelope is permitted, and minimum RSI values are specified for glazing.

Requirements for thermal performance and airtightness of windows and doors have been increased over RS 1980 and NRC Energy Measures requirements.

Other Items

1. Roof ventilation requirements take into account the increased airtightness of the envelope which is now required, and the special problems posed by areas with blowing snow.
2. New provisions for soil drainage and foundation design should ensure successful construction in permafrost conditions.
3. Plumbing requirements have been revised to take into account the widespread use of water and sewage holding tanks in the North.
4. Many provisions have been added to improve general construction and design practices. Some of these originate with the Technical Committee, but many more are adopted from revisions to the 1985 National Building Code.

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